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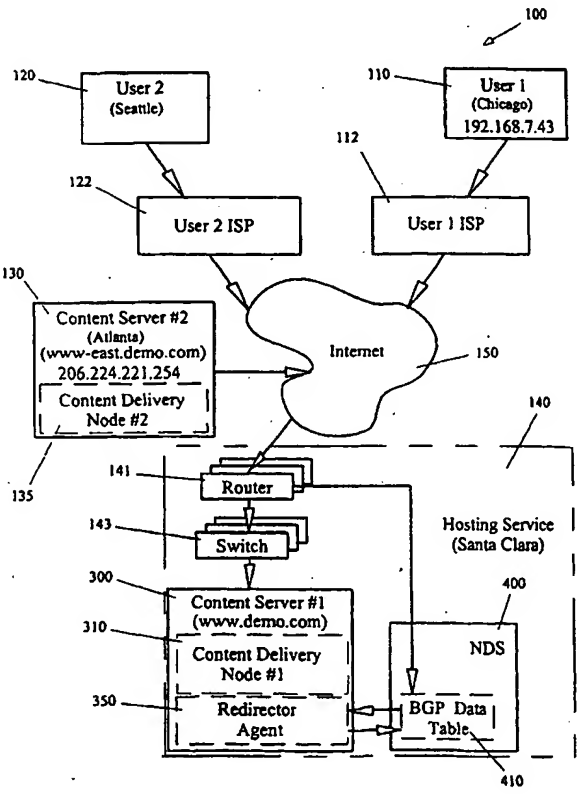
(54) Title: METHOD AND APPARATUS FOR DYNAMIC DETERMINATION OF OPTIMUM CONNECTION OF A CLIENT TO CONTENT SERVERS



(57) Abstract: The method and apparatus of the present invention provide dynamic routing selection of the optimum data server from among many data servers (130, 300) that form a distributed content cache on a communications network (100). A user client (110, 120) enters a request by one of several addressing protocols (112, 120). The method of the invention uses a combination of analytical tools to act upon information contained in the request to determine which of the many distributed content data servers will provide the optimum connection for the user client. Criteria used to make the selection include the type of request, the shortest.

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METHOD AND APPARATUS FOR DYNAMIC DETERMINATION OF OPTIMUM CONNECTION OF A CLIENT TO CONTENT SERVERS

BRIEF DESCRIPTION OF THE INVENTION

The subject of this invention relates to the data communications industry. Specifically, this invention describes a method and apparatus for dynamically determining the optimum one of many servers for delivery of content to a user client terminal.

BACKGROUND OF THE INVENTION

As the use of networks increases, more and more users are turning to network service providers for hosted data services. These service providers operate generally over the Internet, and are thus referred to as Internet Service Providers, or ISPs. It should be noted however that the Internet is not the only possible network topology that provides services to multiple users. Thus the discussion below can apply to a wide variety of network architectures including, but not limited to, local area networks [LANs], wide area networks [WANs], intranets and internets. Further, data communications encompasses a variety of data forms including, but not limited to, voice, video, audio, e-mail and software. For purposes of the present invention the discussion will center on the Internet.

Common to all network structures is the notion of clients and servers. Generally, a client is the source of a request for some service and a server provides that service. It is possible that the same device that is a server can, in a following transaction, become a client. For example, supposing that a user makes a request for some information through his ISP. The user's terminal is the client and the ISP is the server. But the information that the user has requested resides on a different network, thus the ISP must make a request from a different data terminal at some other network location, thus the ISP becomes the client and the distant terminal the server. Note that for purposes of this discussion, a data terminal is considered to be a device having data processing, display and input/output capability. Thus a data terminal could be any number of physical machines including a desktop PC, a laptop PC, a router, or any other device capable of communicating with other such devices.

In modern network architectures, individual data terminals are dispersed in logical and, in most cases, physical space. Some of these data terminal devices are strictly clients and are used by individual users to process data, access data and applications, and communicate with remote data terminal devices. Other data terminal devices act as communication portals and serve as both the server to an end user and as clients of other network data terminal devices. Still other data terminal devices contain large volumes of data and act only as servers, outputting requested data upon demand from a client device.

Modernly, data terminal devices on one network have the ability to communicate with data terminal devices on another network through the use of common protocols. The result is that many networks containing many data servers can be connected to a very large number of user clients. To identify which network and client are to be served, an address scheme has been adopted. Additionally, the demand for certain data, for example, a video feed of a sporting event, can be so large that more than one data server with identical data may be required to satisfy the demand. Typically, a network hosting service will supply these multiple data servers in different geographical parts of the world. These identical servers are referred to as data mirrors, or mirror sites. Mirror sites are used for a number of reasons, including data redundancy, traffic demand, and cost control, however, for this discussion the use of mirror sites is particularly related to optimizing data transfer to user clients.

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Given that multiple mirror sites are available to serve a specific user client, a need arises to determine which of the mirror servers will be used to deliver the requested data. Numerous methods exist in the art to make this decision. These methods fall into two major types: fixed and dynamic. Fixed routing includes such methods as selecting a route from preprogrammed tables, calculating least delivery route cost, least delivery route weight, or least delivery route distance. Dynamic routing methods include deriving the optimum route from data supplied by the user clients and data servers, then making a calculation on-the-fly, or using statistical balancing to determine the best delivery route.

Centralized fixed routing uses a dedicated routing server to pick the optimum route from a table. Sometimes referred to as the minimum hop method, a table is used to determine the shortest distance from a user client to a data server. Variations of this method include the geographic location method and the preprogrammed logical location method. The fixed routing method ignores effects of local traffic demand on a single site, thus it suffers from delays in delivery and increases in connection time and cost, with an attendant reduction in network efficiency.

Another fixed routing method divides the network topology into low speed local and high speed backbone segments, then parses the available data servers into one or the other of the segments. This so-called network parsing method makes the delivery decision predicated upon a preprogrammed elimination of many of the otherwise available nodes based on which segment the node resides in, thus it suffers from inefficient selection of the least busy server. The result is again a less-than-optimal route selection with a potential increase in cost due to increased connection time.

Dynamic route selection methods include the least weight method, the least cost method, and the statistical balancing method. Each of these methods is dynamic since current network topology and traffic data are used to make the routing decision. The least weight method first uses data gathered about the end nodes in a specific communication session to assign a weight to a theoretical connection to all nodes of a network, then, in a second step, uses tabular data about the network topology with corresponding weighted values, and finally, in a third step, chooses the least weight answer from all possible connections formed by the addition of all of the weighted

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values. This method is slow compared to other methods, and suffers further from an aggregation of communication delays throughout the network. The result is delayed connection from the user client to the desired data server.

The least cost method is based on traffic density and unit cost of data transferred. In this method an arbitrary cost is assigned to a set level of traffic such that when traffic on one data server reaches a predetermined value, the cost per unit of data transferred will become high, forcing the algorithm to direct new traffic to a different data server. This method ignores the effects of geographical location, forcing traffic over a longer, more delay prone route when traffic on the desired data server reaches the predetermined level. Further, the method is centralized, so it is prone to service interruptions if the decision making data terminal device fails.

Statistical balancing of user clients is another dynamic route selection method. In this method all of the possible routes are monitored for traffic levels, and the traffic loads balanced on a per server basis. This method, like the cost method above, ignores any geographical advantages, thus possibly choosing a sub-optimal route due to the distance the data must travel.

As can be seen, the existing methods suffer from one or more disadvantages. What would be desirable is a method for choosing an optimum connection from a user client to a data server dynamically and in such a way as to mitigate the disadvantages of the existing methods. Advantageously, the method should simultaneously provide the most efficient and cost effective routing decision.

SUMMARY OF THE INVENTION

The method and apparatus of the present invention provide dynamic routing selection of the optimum data server from among many data servers that form a distributed content cache on a communications network. A user client enters a request by one of several addressing protocols. The method of the invention uses a combination of analytical tools to act upon information contained in the request to determine which of the many distributed content data servers will provide the optimum connection for the user client. Criteria used to make the selection include the type of request, the shortest path, and, when needed, other factors such as route weighting and best bandwidth.

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The method of the present invention combines a number of protocols and test methods to make the optimum routing decision. The protocols include, but are not limited to, HyperText Transfer Protocol [HTTP], HyperText Markup Language [HTML] and Dynamic Name Sever [DNS] addressing using Border Gateway Protocol [BGP] data. A significant advantage over the prior art is that the method of the present invention is platform independent, allowing it to be used for both internal networks, or externally across other networks of different types.

Operation of the present invention is accomplished through use of fully mirrored content data servers, or Content Delivery Nodes [CDN] containing an embedded Redirector Agent, and multiple redundant Node Decision Servers [NDS] located at strategic data hubs within the ISP hosting service. The CDNs may contain a variety of data types, for example live multi-cast, audio, video, standard web pages or simple data libraries. A user client issues a request, for example by entering a Universal Resource Locator [URL] address, which is received and analyzed by the Redirector Agent embedded in the CDN. Having identified the type of protocol to be used, the Redirector Agent queries the NDS for the optimum route decision. The NDS then reviews the status of the network based upon the most current BGP data, including peer outages and geographic location of the CDN closest to the requestor, and makes an optimum connection determination. Once the decision is made, the NDS returns the optimum path data to the Redirector Agent. Based on the received optimum route data from the NDS plus the application of other administrative factors, the Redirector Agent formulates and returns the optimum path data to the user client.

Because the method of the present invention is platform independent, user client requests can vary. For example, the Redirector Agent can receive and react to HTTP tasks submitted by the requestor's web browser and return to the user client the URL of the optimum CDN. Alternatively the method of the present invention can receive DNS lookup data from the requestor and, using a DNS lookup table, return the DNS address of the optimum CDN. A third alternative method delivers embedded HTML instructions containing the appropriate target CDN data.

The array of redundant NDSs receives constant updates as to the status of the network via BGP data which is fresh with each new communications session. Thus if one of a plurality of mirrored CDNs goes off line, the redundant NDS array factors this

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peer outage into the decision criteria. In this way the optimum connection decision is dynamic, and always represents the best decision for any given communications session connection in real time. Once the off-line CDN returns to service, the network status is again updated and the optimum route decision is made accordingly. Thus a significant advantage of the present invention is the ability to provide the optimum connection from a requestor to a content data server in real time. This and other advantages of the present invention are discussed in detail below in conjunction with the figures attached.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a high level block diagram of a system that can make use of a first embodiment of the method of the present invention.

Figure 2 presents a top level state diagram of an embodiment of the method of the present invention.

Figure 3 is a detailed block diagram of a data content server that can make use of the method of the present invention.

Figure 4 is a detailed block diagram of a node decision server that can make use of the method of the present invention.

Figure 5 presents a state diagram of a typical HTTP communications session using the method of the present invention.

Figure 6 presents a state diagram of a typical HTML communications session using the method of the present invention.

Figure 7 presents a state diagram of a typical DNS communications session using the method of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

As described briefly above, there are a number of disadvantages with the current methods for optimizing the distribution of content from remotely located data servers including delays, sub optimum efficiency, and service interruptions among others. The method of the present invention overcomes these disadvantages by providing a method and associated apparatus that allows dynamic determination of the

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most optimal target data server for content delivery without insertion of undesirable delays.

The method of the present invention will be more clearly understood through a brief discussion of the environment in which the invention operates. Note that for the detailed discussion that follows the terms "client" and "server" are used in their technical sense. That is, where a device is the source of a request, it is referred to as a client, whereas the same device responding to a request is referred to as a server.

Referring to Fig. 1, a high level block diagram of a system **100** that can make use of the present invention is shown. A Hosting Service **140** provides data services for numerous users. In this configuration, the Hosting Service **140** is located geographically in Santa Clara. The Hosting Service **140** maintains a number of Routers **141** and Switches **143** that interface to data content servers such as Content Server #1 **300**. As is known to those of skill in the art, this is not the only possible host services configuration and is shown here as an example only. Other configurations could be used without departing from the spirit of the invention, for example, the Switches **143** could be eliminated for smaller host configurations.

The Content Server #1 **300** contains, among other data and programs, a Content Delivery Node #1 **310** and a Redirector Agent **350**. As will be discussed in greater detail below, the Content Delivery Node #1 **310** contains the information that a remote user is seeking and is one of several mirrored content sites. The Redirector Agent **350**, also discussed in detail below, is a program that receives users' requests, processes user address data, and interfaces with a Node Decision Server [NDS] **400**, also located at the Hosting Service **140**. The NDS **400** uses the Border Gateway Protocol [BGP] Data Table **410** to make a decision as to which of a plurality of mirrored data content servers will be the best for a particular user and communications session.

The BGP Data Table **410** is updated with current network status with each new communications session. These data are contained in the incoming message and are sent to the NDS **400** by the Router **141** as part of its normal operation. The NDS **400** then interprets the BGP data sent and updates the BGP Data Table **410**. Each time a new communications session is started, regardless of the specific user, updated BGP data are sent to the BGP Data Table **410**. In this way the method of the present

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invention maintains a detailed status of the current network conditions, including peer outages and active routes, advantageously allowing for a more accurate determination of an optimum content delivery path.

An example of a mirrored data content server is Content Server #2 **130** in Atlanta. Content Server #2 **130** contains the identical data content as Content Server #1 **300** as well as Content Delivery Node #2 **135**. As will be discussed below, this fully mirrored configuration has several nontrivial advantages over the prior art including more rapid determination of the optimum data content server for a particular user and communications session.

Shown in Fig. 1 are two typical remote users, User 1 **110** in Chicago and User 2 **120** in Seattle. These users each have an Internet Service Provider [ISP] (User 1 ISP **112** and User 2 ISP **122** respectively) connecting them to the Internet **150**. The function of an ISP is well understood by those of skill in the art and is thus not treated in detail as part of this discussion. These users have a need to connect to a content provider's information and do so by requesting the establishment of a communications session with a target data content server.

Fig. 2 presents a high level state diagram **200** of the method of the present invention. While there are numerous specific instances of the use of BGP data by the method of the present invention, each discussed in detail below, Fig. 2 is appropriate for describing the method at a high level of granularity. The process begins when the User **210** requests a communications session. Note that the User **210** in Fig. 2 is equivalent to User 1 **110** in Fig. 1 but is labeled differently here for clarity. Note further that Router **230**, Redirector Agent **280**, and NDS **250** all are equivalent to their counterparts in Fig. 1 but are labeled differently for clarity in Fig. 2.

The User Request **215** is sent to a Router **230**. The Router **230** sends the incoming message to the NDS **250** in the Send BGP data step **234**. The NDS **250** interprets the BGP data contained in the incoming message in the Interpret BGP Data step **252** and then updates the BGP table at the Update BGP Data Table step **254**. At this point in time the NDS **250** has a real time status of the entire network to use in its decision making process. The Router **230** also delivers the request to the Redirector Agent **280** at the Deliver Request step **236**.

Once the Redirector Agent **280** has received the request, the Determine Request Type step **282** is executed in order for the method of the present invention to understand what type of communication protocol is being used by the user's client device. After making this determination the Redirector Agent **280** forms a query and sends it to the NDS **250** via the Query NDS for Best Server step **284**. Using the very recently updated network status the NDS executes a Look-up Best Server step **265** and returns the results of the decision process to the Redirector Agent **280** in the Best Server Response step **258**.

Having received the best data content server decision from the NDS **250**, the Redirector Agent **280** executes the Apply Other Admin Factors step **286** prior to sending the optimum route decision via the Return Best Server step **288**. Other administrative factors may include such information as customer status, current traffic conditions and content status among others. The Router **230** receives the optimum data content server path information from the Redirector Agent **280** and passes it back to the User **210** via the Best Choice step **238**.

Fig. 3 provides the relevant detail of a typical Content Server **300**, such as Content Server #1 in Fig. 1. The server contains, among other things, a Content Delivery Node #1 **310**, in this case having a Universal Resource Locator [URL] of www-west.demo.com. Also contained in Content Server **300** is a Redirector Agent **350**. The redirector agent is a software program containing a Front End Processor module **352**, Application/Configuration Table **355** and NDS Interface module **358**. As will be obvious to those of skill in the art, a typical content server will contain many other components, both hardware and software, that are not relevant to the method of the present invention and are thus not addressed in this discussion.

While each of the modules contained in the Redirector Agent **350** will be discussed in greater detail in conjunction with Figs. 5 through 7 below, in general, the Front End Processor module **352** is responsible of accepting a user's request, parsing the incoming data, analyzing the data and formulating a decision query to be sent to the NDS. The query is based upon what type of application has been sent by the user, thus the Application/Configuration Table **355**, containing pre-configured data related to types of applications expected from users, is checked by the Front End Processor module **352** and the proper data is fetched for use in formulating the query to the NDS.

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The NDS Interface module **358** is used to send queries and receive responses from the NDS.

Fig. 4 is a detailed block diagram of the NDS **400** in Fig. 1. The NDS **400** contains, among other things, the BGP Data Table **410**, the BGP Interpreter module **420**, The Network Status Data Table **430** and the Redirector Agent Interface module **440**. Note that the NDS **400** may contain other hardware and software that are not relevant to the method of the present invention and are thus not addressed in this discussion.

BGP Interpreter module **420** interprets the incoming message and extracts BGP data. These fresh data are then sent to the BGP Data Table **410**, and, in combination with the geographic location data from the Network Status Data Table **430**, form the decision data to be used in determining the optimum data content server location for the particular user request. The exact method for selection of the best possible data content server varies with the type of user request thus is not discussed in detail here; however, each method is covered in detail in conjunction with Fig.s 5 through 7 below. Redirector Agent Interface module **440** receives queries from and sends responses to the NDS Interface module, **358** of Fig. 3.

Recall that the precise best route selection method depends upon what application was used by the user to establish the communication session. Figs. 5 through 7 provide the process details for three types of communication sessions. These application types are exemplary in nature, and do not represent a limitation on the scope of the present invention. For Figs. 5 through 7 state diagrams have been used for clarity of understanding. It will be recognized by those of skill in the art that within each of the states shown various smaller steps are executed which do not add to the understanding of the method of the present invention and have been aggregated for clarity.

Fig. 5 presents a detailed state diagram **500** of the present invention using the HTTP redirect method. With this method the process starts with the User **510**, whose IP address happens to be 192.168.7.43, issuing a request to connect to www.demo.com at User Request **515**. The request takes the form of an HTTP GET/file.exe command. The Router **530** receives the command and then delivers the request via the Deliver Request step **536** to a Redirector Agent **580** embedded in a content server, for

example, Content Server #1 **300** in Fig. 1. Note that the Router **530** accomplishes other tasks as explained in conjunction with Fig. 2 above, for example, delivering the request message to the NDS **550** to accomplish the BGP data update.

The Redirector Agent **580** uses the data contained in the Application/Configuration Table, **355** of Fig. 3, to determine which type of communications protocol is being used at the Determine Request Type step **582**. Once determined, a query is formed and sent to the NDS **550** at the Best Server for 192.168.7.43 step **584**. Within the NDS **550** the Look-up Best Server step **556** determines the closest geographic data content server to the user from among a plurality of data content servers. Once the optimum geographical data content server has been determined, the NDS **550** responds to the Redirector Agent **580** with the location data at the Best Server = Content Server #2 step **558**.

The decision in the NDS **550** is based upon the current BGP data, the geographic locations of all possible relevant data content servers, which of the relevant data content servers have active routes, and which are administratively up or down. Where multiple geographic locations with active routes exist that are otherwise equal, a random distribution method of route assignment is used. In the example shown in Fig. 5, the optimum data content server selected by the NDS **550** happens to be Content Server #2 (**130** of Fig. 1) located in Atlanta. This comports with the geographic location of the User **510** who is located in Chicago. Were the incoming request from User 2, **120** in Fig 1., located in Seattle, the NDS **550** would respond with Content Server #1 (**300** of Fig. 1) instead, since it is located in Santa Clara.

Once the Redirector Agent **580** has received the response from the NDS **550**, other relevant data are applied to the decision at the Apply Other Admin Factors step **586**. Here, such factors as data content server loading, availability and data status are used to ensure that the proper content server has been selected. At step **588**, Return Best Server, the Redirector Agent **580** passes the decision to the Router **530**, which in turn sends the optimum route to the User **510** via the Best Choice = step **538**. Thus in this instance, a 302 HTTP://www-east.demo.com/file.exe redirect command is passed back to the user. The user's device then executes the command and connects the user to the appropriate data content sever via the optimum path.

Fig. 6 presents a detailed state diagram **600** of the present invention using the embedded HTML command method. With this method the process again starts with the User **610,** whose IP address again happens to be 192.168.7.43, issuing a request to connect to www.demo.com at User Request **615**. The request takes the form of an HTTP GET/index.html command. The Router **630** receives the command and then delivers the request via the Deliver Request step **636** to a Redirector Agent **680** embedded in a content server, for example, Content Server #1 **300** in Fig. 1. Note that the Router **630** accomplishes other tasks as explained in conjunction with Fig. 2 above, for example, delivering the request message to the NDS **650** to accomplish the BGP data update.

The Redirector Agent **680** uses the data contained in the Application/Configuration Table, **355** of Fig. 3, to determine which type of communications protocol is being used at the Determine Request Type step **682**. In this instance, the determination is made that an embedded HTML protocol has been received from the user. Steps **684** through **686** perform the same functions in the same manner as their counterparts in Fig. 5 and therefore are not detailed here. At step **688,** Return Best Server, the Redirector Agent **680** passes the decision to the Router **630,** which in turn sends the optimum route to the User **610** via the Best Choice = step **638**. Thus in this instance, an HTTP://www-east.demo.com/index.html redirect command is passed back to the user. The user's device then executes the command and connects the user to the appropriate data content sever via the optimum path.

Fig. 7 presents a detailed state diagram **700** of the present invention using the DNS lookup method. With this method the process again starts with the User **710,** whose IP address again happens to be 192.168.7.43, issuing a request to connect to www.demo.com at User Request **715**. The request takes the form of a DNS lookup www.demo.com command. The Router **730** receives the command and then delivers the request via the Deliver Request step **736** to a Redirector Agent **780** embedded in a content server, for example, Content Server #1 **300** in Fig. 1. Note that the Router **730** accomplishes other tasks as explained in conjunction with Fig. 2 above, for example, delivering the request message to the NDS **750** to accomplish the BGP data update.

The Redirector Agent **780** uses the data contained in the Application/Configuration Table, **355** of Fig. 3, to determine which type of

communications protocol is being used at the Determine Request Type step **782**. In this instance, the determination is made that a DNS lookup protocol has been received from the user. Steps **784** through **786** perform the same functions in the same manner as their counterparts in Fig. 5 and therefore are not detailed. At step **788**, Return Best Server, the Redirector Agent **780** passes the decision to the Router **730**, which in turn sends the optimum route to the User **710** via the Best Choice = step **738**. Thus in this instance, a DNS address of 206.224.221.254 is passed back to the user. The user's device then executes the connection to the appropriate data content sever via the optimum path in the normal manner.

A first advantage of the present invention is the ability to make an optimal route decision based on current network status. This is accomplished by reading and storing network conditions gained from fresh BGP data contained in each new session.

A second advantage of the present invention is the speed of the optimum route decision process. Rapid route selection reduces the user delays in connecting to the best content server thereby reducing overall network traffic and increasing efficiency.

A third advantage of the present invention is that it is platform independent. The Redirector Agent can be embedded in various communications environments making it broadly available to networks of all sizes and configurations.

A fourth advantage of the present invention is that it is application independent. Since the Redirector Agent is pre-configured based upon client protocol preferences, a variety of communication applications may be served from the same network hosting environment.

A fifth advantage of the present invention is that it is expandable. As new protocols and/or communications applications become available, the Redirector Agent can be programmed to recognize, analyze and react in an appropriate manner.

A sixth advantage of the present invention is that it is configurable on a client-by-client basis. This advantage allows the present invention to be changed as a client's needs change with little effort and expense.

A seventh advantage of the present invention is that it is mirrored. This redundancy of both data and process greatly increases the dependability of the method of the present invention and significantly reduces the deterioration in performance related to network outages.

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An eighth advantage of the present invention is that it is economical since makes the optimum route selection based on best performance at the specific point in time when the user makes the content request. This is done through use of a many network factors including bandwidth, equipment status, geographic considerations, and session type, as well as others.

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What is claimed is:

1. A method of providing dynamic determination of an optimal content server to service a request from a remote user terminal, comprising:

receiving a request from a remote user terminal, said request containing request data and protocol data;

updating a network status data table using said protocol data;

determining a request type based upon said request data;

comparing said request type to content server selection criteria contained in a network status data table;

choosing an optimal content server based upon said request type and said content server selection criteria; and

communicating information defining said optimal content server to said remote user terminal.

2. The method of Claim 1 wherein said determining step comprises the steps of:

parsing said request data;

characterizing said request data in accordance with request types maintained in an application/configuration table;

forming an optimal content server query; and

sending said optimal content server query to a content server node decision module.

3. The method of claim 2 wherein said characterizing step includes the step of characterizing said request data in accordance with requests types including Hypertext Transfer Protocol requests, Hypertext Markup Language requests, and Dynamic Name Server requests.

4. The method of claim 1 wherein said updating step includes updating said network status data

table with Border Gateway Protocol data.

5. The method of claim 1 wherein said choosing step includes the step of choosing an optimal

content server based upon said request type and content server selection criteria including updated network status, updated network communications bandwidth, user geographic data, and content server geographic data.

6. A computer readable memory to direct a digital device to function in a specified manner, comprising:

a redirector agent program including a front end processor module, an application/ configuration data table module, and a node decision server interface module, said redirector agent program identifying a user request type and an optimal server query to process a user request; and

a connection decision program including a protocol data table module, a protocol Interpreter module, a network status data table module and a redirector agent interface module, said connection decision program producing an optimal content server command corresponding to an optimal content server to process said user request.

7. The computer readable memory of claim 6 wherein said redirector program and said connection decision program are executed at a single geographic location.

8. The computer readable memory of claim 6 wherein said redirector program and said connection decision program are executed at different geographical locations.

9. The computer readable memory of claim 6 wherein said redirector program and said connection decision program are replicated at a plurality of geographic locations.

1/23/2007, EAST Version: 2.1.0.14

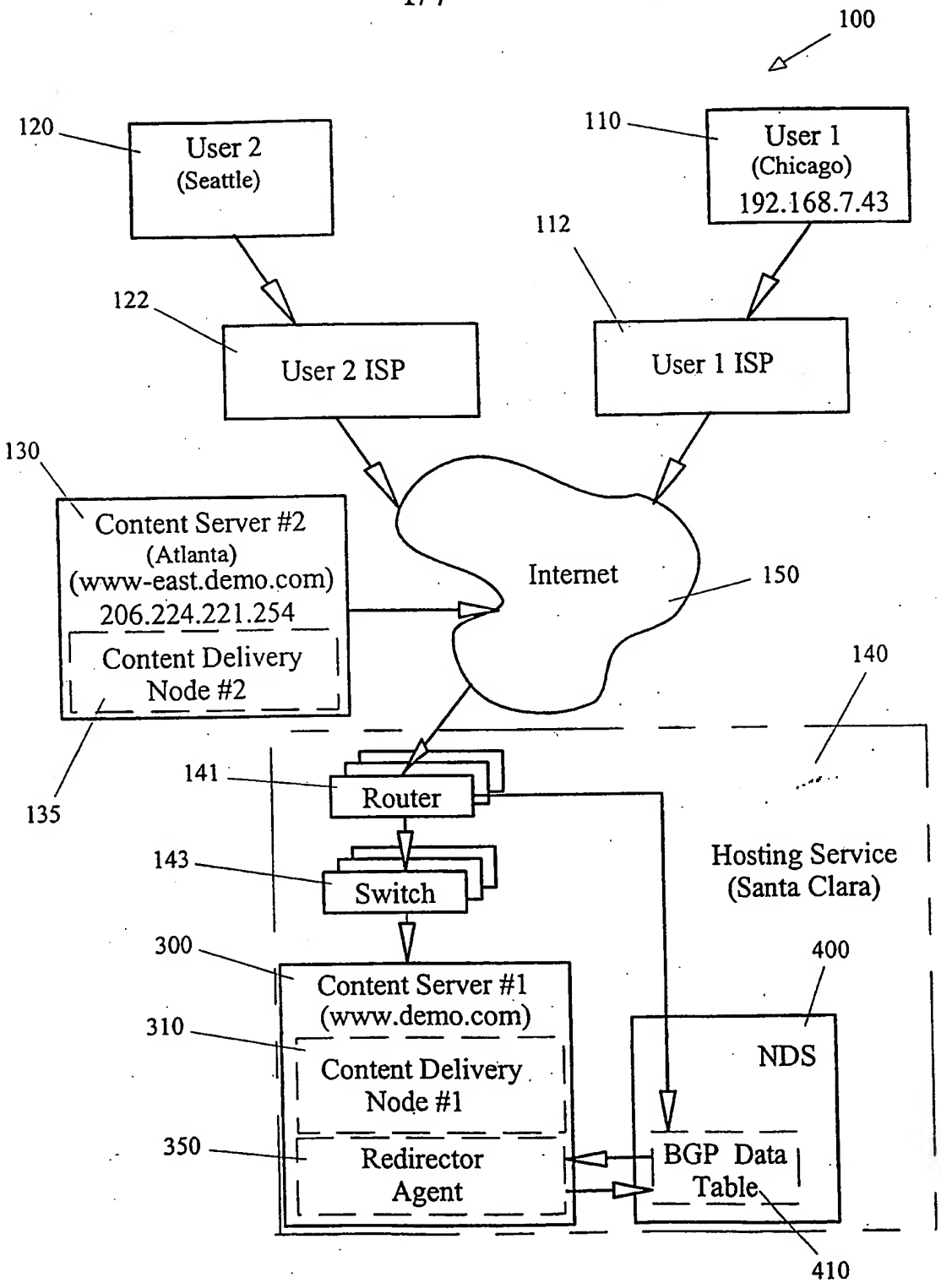
100
120
User 2
(Seattle)
110
User 1
(Chicago)
192.168.7.43
112
122
User 2 ISP
User 1 ISP
130
Content Server #2
(Atlanta)
(www-east.demo.com)
206.224.221.254
Content Delivery
Node #2
Internet
150
140
135
141
Router
143
Switch
Hosting Service
(Santa Clara)
300
Content Server #1
(www.demo.com)
400
310
Content Delivery
Node #1
NDS
350
Redirector
Agent
BGP Data
Table
410

Fig. 1

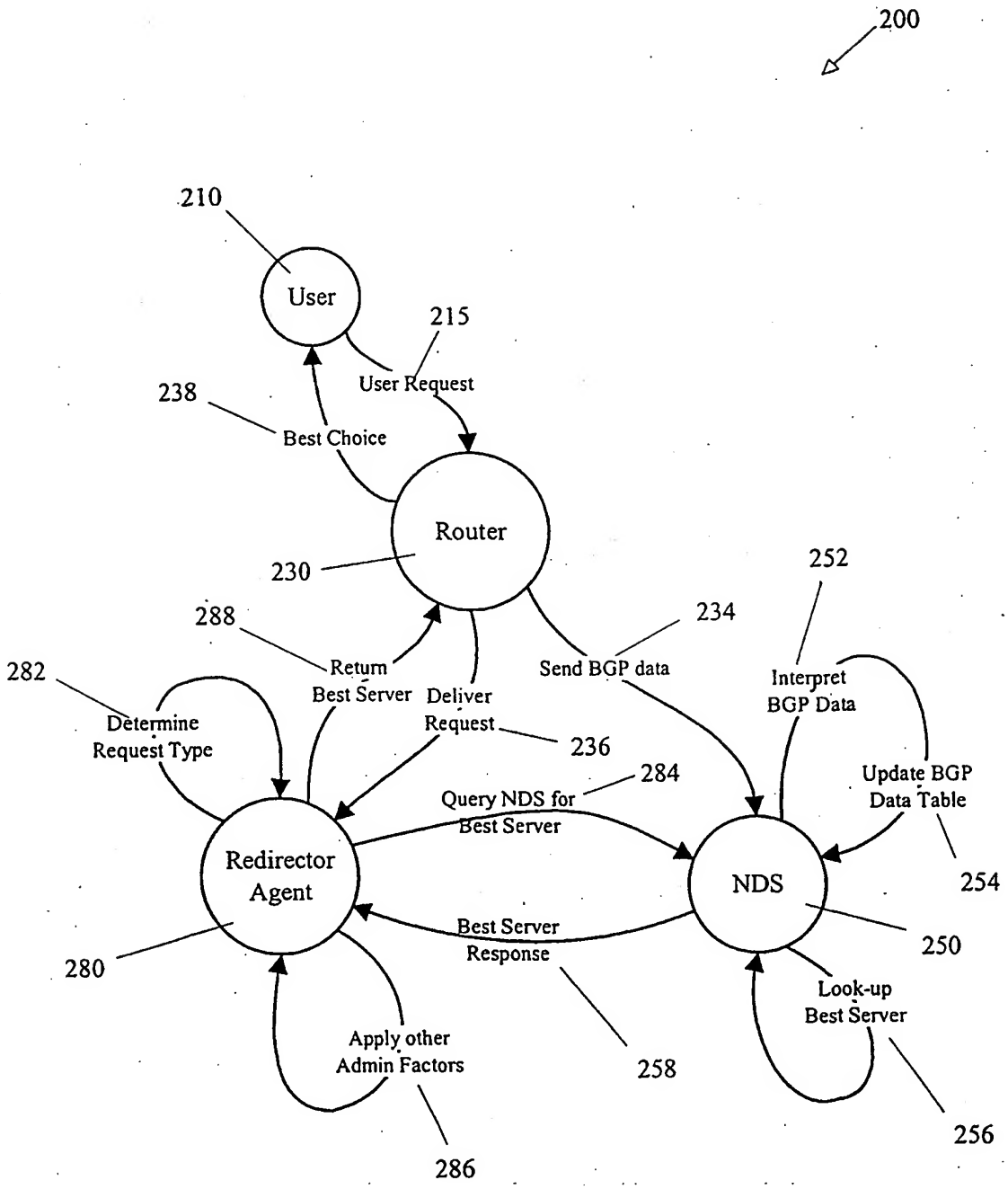
200
210
User
215
User Request
238
Best Choice
Router
230
252
288
234
Return
Best Server
Deliver
Request
Send BGP data
Interpret
BGP Data
282
Determine
Request Type
236
284
Update BGP
Data Table
Query NDS for
Best Server
Redirector
Agent
NDS
254
Best Server
Response
250
280
Look-up
Best Server
Apply other
Admin Factors
258
256
286

Fig. 2

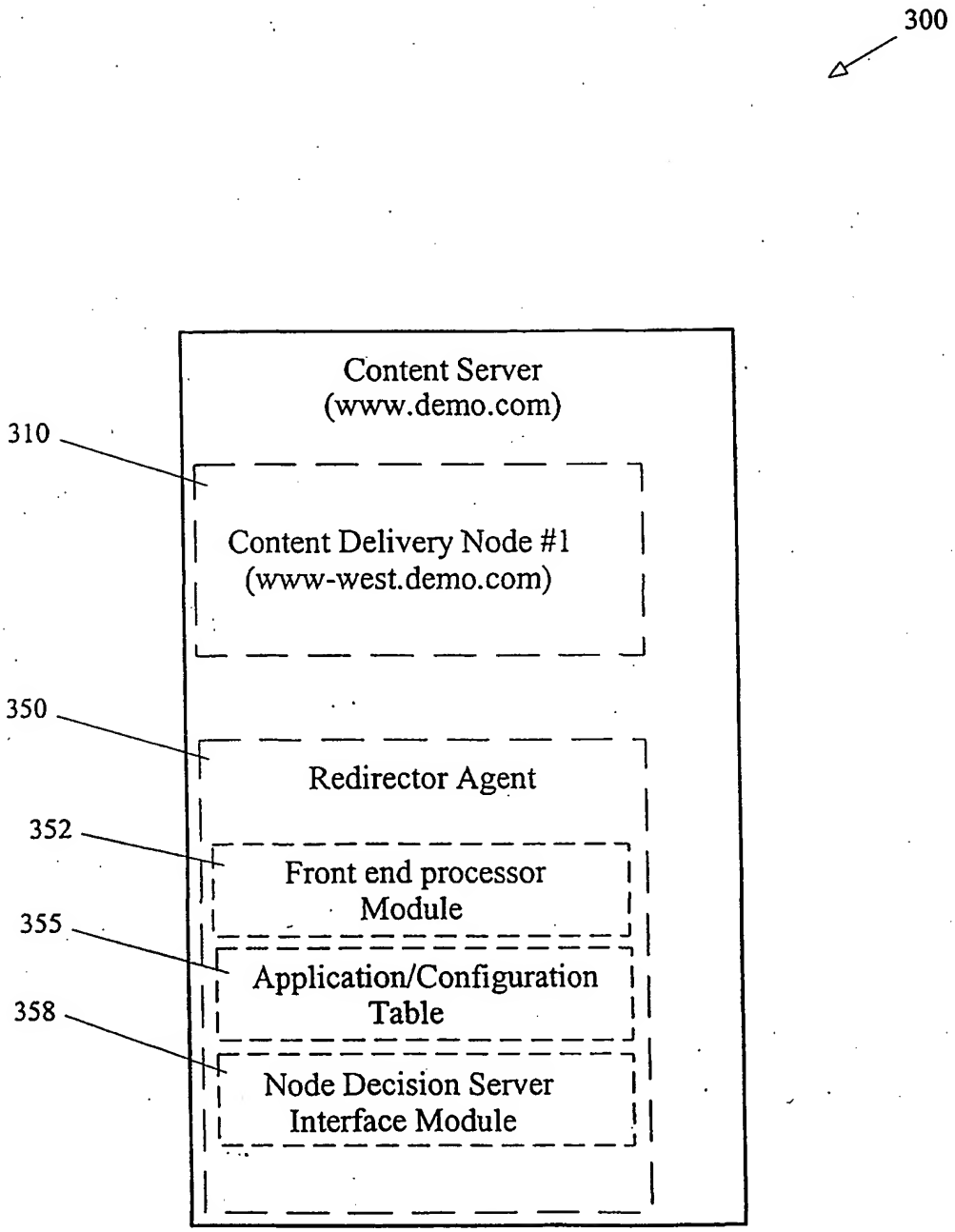
300
Content Server
(www.demo.com)
310
Content Delivery Node #1
(www-west.demo.com)
350
Redirector Agent
352
Front end processor
Module
355
Application/Configuration
Table
358
Node Decision Server
Interface Module

Fig. 3

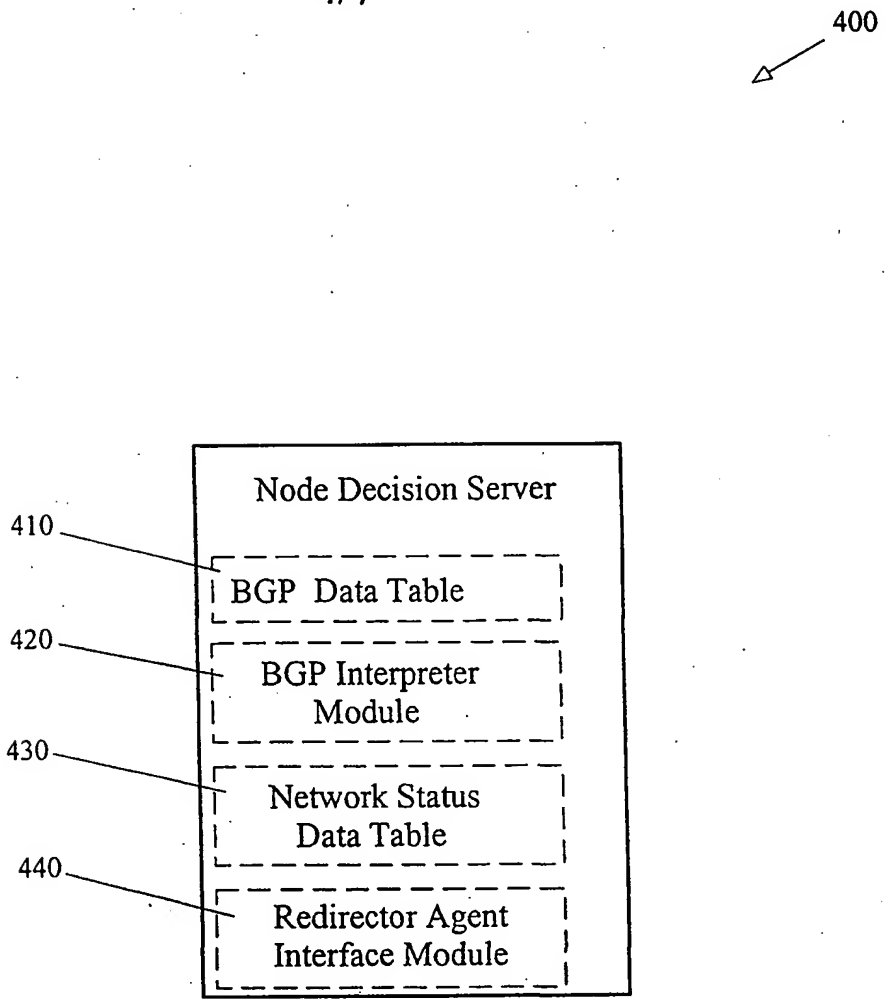
400
Node Decision Server
410
BGP Data Table
420
BGP Interpreter Module
430
Network Status Data Table
440
Redirector Agent Interface Module

Fig. 4

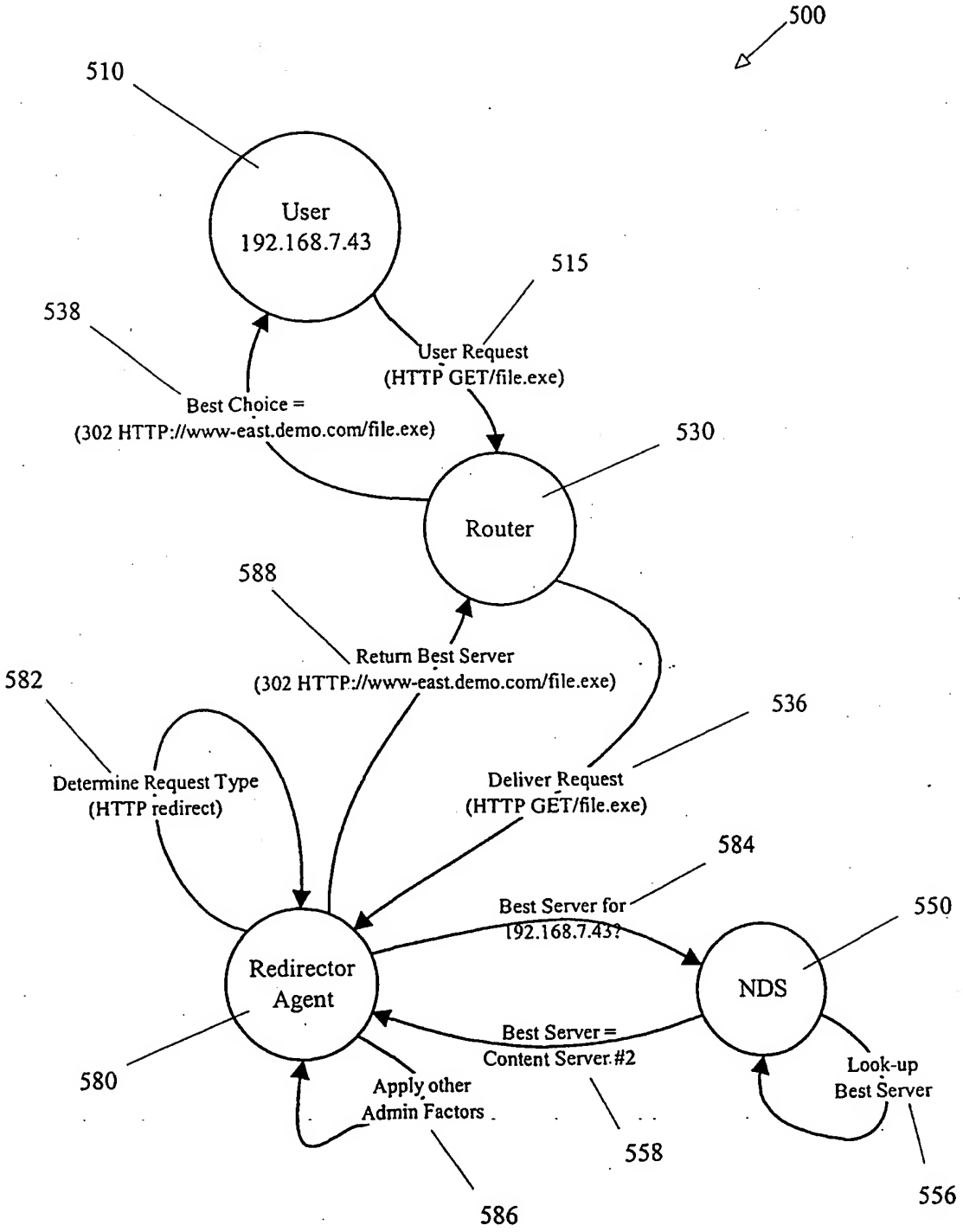
500
510
User
192.168.7.43
515
538
User Request
(HTTP GET/file.exe)
Best Choice =
(302 HTTP://www-east.demo.com/file.exe)
530
Router
588
Return Best Server
(302 HTTP://www-east.demo.com/file.exe)
582
536
Determine Request Type
(HTTP redirect)
Deliver Request
(HTTP GET/file.exe)
584
Best Server for
192.168.7.43?
550
Redirector
Agent
NDS
Best Server =
Content Server #2
580
Apply other
Admin Factors
Look-up
Best Server
558
556
586

Fig. 5

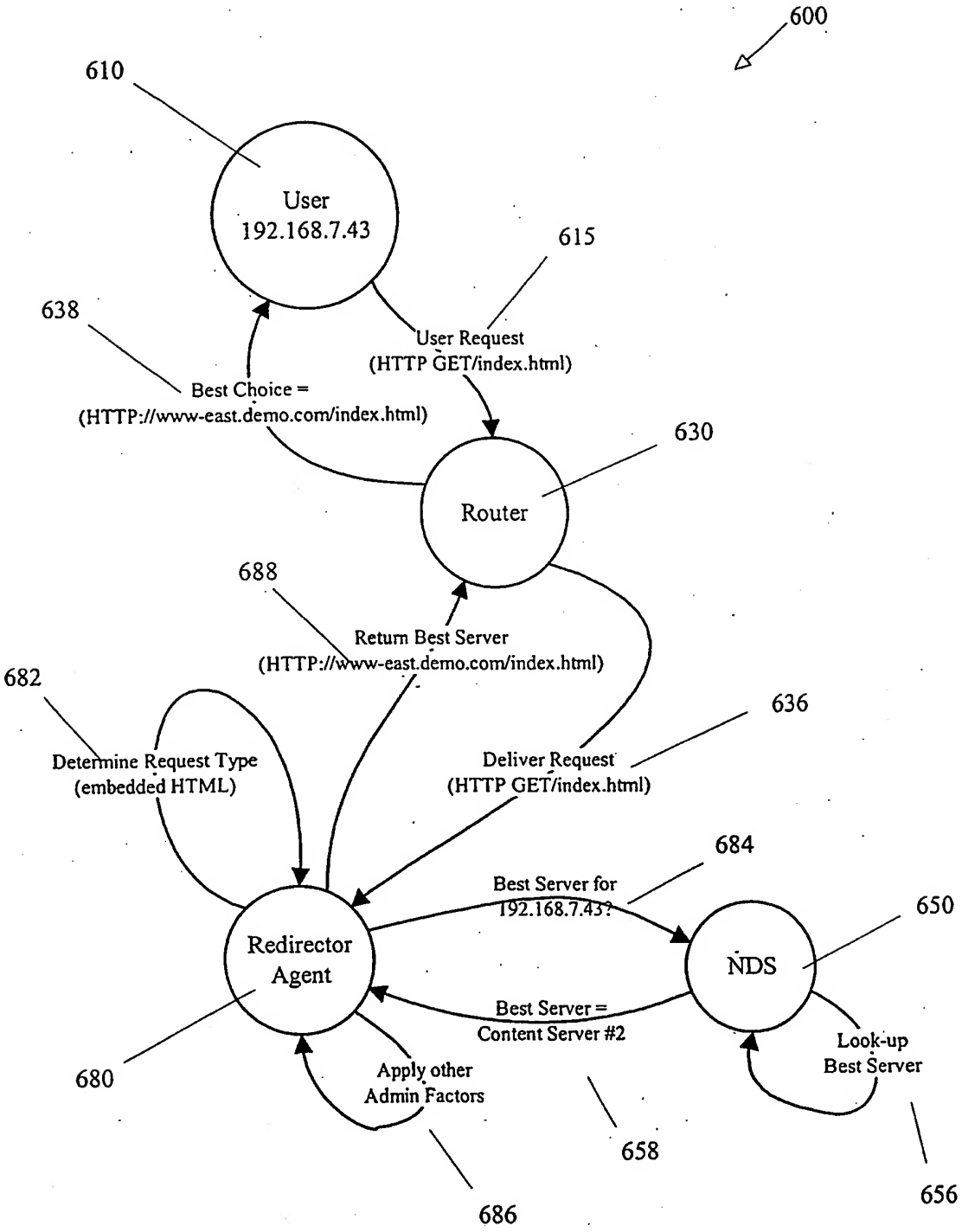
600
610
User
192.168.7.43
615
638
User Request
(HTTP GET/index.html)
Best Choice =
(HTTP://www-east.demo.com/index.html)
630
Router
688
Return Best Server
(HTTP://www-east.demo.com/index.html)
682
636
Determine Request Type
(embedded HTML)
Deliver Request
(HTTP GET/index.html)
684
Best Server for
192.168.7.43?
650
Redirector
Agent
NDS
Best Server =
Content Server #2
Look-up
Best Server
680
Apply other
Admin Factors
658
656
686

Fig.6

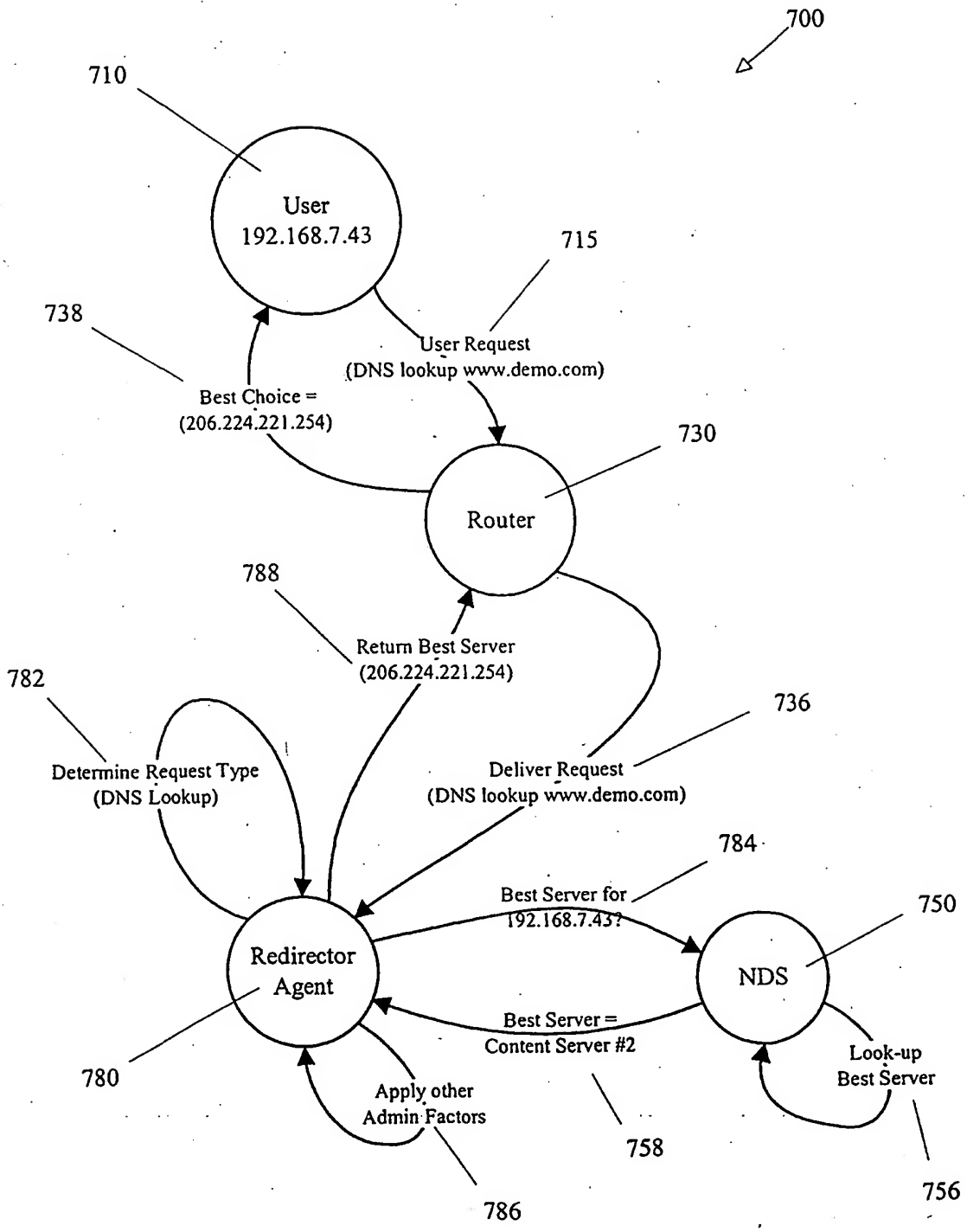
700
710
User
192.168.7.43
715
User Request
(DNS lookup www.demo.com)
738
Best Choice =
(206.224.221.254)
730
Router
788
Return Best Server
(206.224.221.254)
782
Determine Request Type
(DNS Lookup)
736
Deliver Request
(DNS lookup www.demo.com)
784
Best Server for
192.168.7.43?
750
Redirector
Agent
NDS
Best Server =
Content Server #2
780
Apply other
Admin Factors
758
Look-up
Best Server
756
786

Fig.7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/29524

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :G06F 15/16, 13/14, 13/00
US CL : 709/203, 217, 219, 224, 229; 710/33; 395/725
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 709/203, 217, 219, 224, 229; 710/33; 395/725

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y, P	US 6,286,029 B1 (DELPH) 04 September 2001, abstract, figure 1, col. 1 lines 57-col. 2 lines 7, col. 2 lines 57-col. 3 lines 30, col. 4 lines 67-col. 6 lines 5, col. 8 lines 25-47.	1-9
Y, P	US 6,233,607 B1 (TAYLOR et al) 15 May 2001, abstract, col. 1 lines 45-col. 2 lines 7, col. col. 4 lines 59-col. 5 lines 9.	1-9
Y, P	US 6,182,122 B1 (BERSTIS) 30 January 2001, abstract, figures 5, 6, 8, col. 1 lines 47-54, col. 2 lines 27-42, col. 2 lines 56-col. 3 lines 15, col. 7 lines 8-39.	1-9

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 05 NOVEMBER 2001	Date of mailing of the international search report 28 DEC 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer AYAZ R. SHEIKH Telephone No. (703) 305-9648

Form PCT/ISA/210 (second sheet) (July 1998)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/29524

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y, P	US 6,173,322 B1 (HU) 09 January 2001, abstract, figures 1, 9, col. 2 lines 27-col. 3 lines 25, col. 7 lines 53-col. 8 lines 59, col. 9 lines 66-col. 10 lines 64, col. 11 lines 60-col. 12 lines 65, col. 16 lines 25-col. 17 lines 47.	1-9
Y	US 6,108,706 A (BIRDWELL et al) 22 August 2000, abstract, figures 1, 3, 4, col. 1 lines 20-col. 2 lines 32, col. 2 lines 50-col. 3 lines 9, col. 4 lines 40-54, col. 6 lines 52-col. 7 lines 3, col. 7 lines 50-col. 8 lines 39.	1-9
Y	US 6,016,520 A (FACQ et al) 18 January 2000, abstract, col. 1 lines 55-col. 3 lines 7, col. 7 lines 45-col. 8 lines 16, col. 16 lines 27-49.	1-9
Y	US 5,418,967 A (SIMCOE et al) 23 May 1995, abstract, figures 3, 5, col. 1 lines 34-45, col. 18 lines 12-col. 19 lines 19.	1-9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/29524

B. FIELDS SEARCHED
Electronic data bases consulted (Name of data base and where practicable terms used):

East, West
Search terms: client/server, remote data processing, accessing a remote server, remote client/ terminal, content servers, request type, client/server connection.

1/23/2007, EAST Version: 2.1.0.14